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## (54) ELECTRICAL DUOUBLE-LAYER CAPACITOR

### (57)Abstract:

PROBLEM TO BE SOLVED: To provide an electrical double-layer capacitor, which suppresses the reaction of the surface functional group of activated carbon and electrolyte and of which the durability improves.

SOLUTION: At the time of mixing activated carbon powder, carbon black and PTFE in ethyl carbinole to prepare a paste, the pH is adjusted by hydrochloric acid or ammonia. The paste is applied to a collector, it is backed and pressed. The a polarizable electrode is formed and it is stacked through a separator. The plolarizable electrode and the separator are impregnated with electrolytes whose pH is equal to the polarizable electrode, and the electrical double layer capacitor is fabricated. When the pH of the polarizable electrode and that of eletrolyte are made equal, the durability improves. When pH is set to be around, the operating voltage can be made high. When the pH is set to be under 9, the capacitance can be made large. When the pH is set to be higher than a, the efficiency can be improved.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

#### [0001]

[Field of the Invention] This invention adjusts pH of an electric double layer capacitor especially an electrode, and the electrolytic solution, and relates to the electric double layer capacitor whose endurance improved.

#### [0002]

[Description of the Prior Art] An electric double layer capacitor carries out the laminating of the polarizable electrode of a positive/negative pair through a separator, and sinks the electrolytic solution into this polarizable electrode and separator. A polarizable electrode usually mixes activated carbon, and carbon black and the graphite as electric conduction-ized material with binders, such as PTFE, it applies on a charge collector what was considered as the paste, calcinates it, and is constituted. The technique which pH of the electrolytic solution mentioned above is adjusted, and the technique of raising the engine performance of an electric double layer capacitor is indicated conventionally, for example, sets the electrolytic solution to two or more pH at JP,61-232605,A is indicated.

#### [0003]

[Problem(s) to be Solved by the Invention] However, in case an electric double layer capacitor is actually assembled, the present condition is that adjustment is not performed at all about pH of the electrolytic solution. In such a case, there was a problem which exists in the front face of the activated carbon which constitutes the polarizable electrode of a labile surface functional group dissociating a hydrogen ion and a hydroxide ion in the electrolytic solution, and these ion having reacted with the electrolytic solution, having generated gas and decomposition products, such as carbon dioxide gas, and bringing about the performance degradation of an electric double layer capacitor by this. As an example of such performance degradation, an electrode active material exfoliates from a charge collector according to generating of gas, or a decomposition product adheres to an electrode surface, adsorption of ion is barred, and it is possible to bring about the fall of capacity etc. Such performance degradation usually advances while in use, and turns into degradation of the endurance of an electric double layer capacitor.

[0004] This invention is made in view of the above-mentioned conventional technical problem, and the purpose controls the reaction of the surface functional group of activated carbon, and the electrolytic solution, and is to offer the electric double layer capacitor whose endurance improved.

#### [0005]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the 1st invention is an electric double layer capacitor which has the electrolytic solution with which it sank into the separator which intervened between the polarizable electrodes of positive/negative, and these polarizable electrodes, and a polarizable electrode and a separator, and is characterized by making pH of a polarizable electrode and the electrolytic solution equal.

[0006] Moreover, 2nd invention is characterized by Above pH being 9 in the electric double layer capacitor of the 1st invention.

[0007] Moreover, 3rd invention is characterized by Above pH being less than nine in the electric double layer capacitor of the 1st invention.

[0008] Moreover, 4th invention is characterized by Above pH being larger than 9 in the electric double layer capacitor of the 1st invention.

#### [0009]

[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained based

on a drawing.

[0010] this invention persons investigated the relation between pH of the electrolytic solution used for an electric double layer capacitor, and a polarizable electrode, and the engine performance of an electric double layer capacitor. In this case, it is defined as pH of a polarizable electrode as pH the water immersed in that polarizable electrode indicates a polarizable electrode to be when immersed underwater.

[0011] When pH of a polarizable electrode and pH of the electrolytic solution became equal as a result of investigation, it turned out that the endurance of an electric double layer capacitor improves. Endurance will be high, so that the fall of the electrostatic capacity endurance means a ratio with the electrostatic capacity after repeating the early electrostatic capacity and early charge and discharge of an electric double layer capacitor, and according to the repeat of charge and discharge is small. Here, exfoliation of the electrode active material from a charge collector and adhesion in the electrode surface of a decomposition product are considered to be the causes as the fall of electrostatic capacity was mentioned above. As mentioned above, if pH of a polarizable electrode and the electrolytic solution becomes equal, it will be controlled that a hydrogen ion and a hydroxide ion are isolated from the surface functional group on the front face of activated carbon, and it can control generating of gas, such as carbon dioxide gas, and the generation of a decomposition product by the reaction of these ion and the electrolytic solution, for this reason it will be thought that the endurance of an electric double layer capacitor improves.

[0012] In this case, if pH of a polarizable electrode and the electrolytic solution is made less than into nine, the surface functional group on the front face of activated carbon will come to contain many acid functional groups, adsorbent [ of ion ] will improve, and the capacity of an electric double layer capacitor will increase.

[0013] Moreover, if pH of a polarizable electrode and the electrolytic solution is made into the nine neighborhoods, the electrical potential difference which can impress the usable electrical potential difference of an electric double layer capacitor between high-voltage-izing, i.e., a forward negative electrode, can be made high. Although the immersion potential of activated carbon changes according to pH of the electrolytic solution as this is shown in drawing 1, immersion potential becomes low most in the pH=9 neighborhood. According to the experiment of this invention persons, the difference with the potential which a potential window, i.e., immersion potential, and an irreversible current generate in the case of activated carbon is because it is narrower than - side + side, so the one where immersion potential is lower can take the large potential window by the side of + and high-voltage-ization of an electric double layer capacitor can be attained by this.

[0014] Furthermore, if pH of a polarizable electrode and the electrolytic solution is made larger than 9, since the ion by which the acid functional group on the front face of activated carbon decreases, and a trap is carried out into the micropore of activated carbon will decrease in number, effectiveness of an electric double layer capacitor can be made high. In this case, effectiveness is the rate of the charge charge at the time of making charge and discharge perform to an electric double layer capacitor, and a discharge charge.

[0015] Hereafter, the example of the electric double layer capacitor concerning this invention is explained as an example.

[0016] After having mixed example . activated carbon powder, carbon black, and PTFE with the ball mill in ethyl carbitol for 1 hour, creating the paste and applying on aluminium foil, the baking press was carried out and the polarizable electrode was produced. After adjusting this polarizable electrode to pH of arbitration and carrying out a laminating through a separator, the electrolytic solution adjusted to the same pH as a polarizable electrode was sunk into the polarizable electrode and the separator, and the electric double layer capacitor was constituted. Then, after dehydrating to about 30 ppm by molecular sieves, the engine performance of each electric double layer capacitor was evaluated. The acidity side was carried out with the hydrochloric acid, it carried out the basicity side with ammonia, and adjustment of pH mentioned above produced and evaluated pH=3 and three kinds of electric double layer capacitors of 9 and 11 as pH of a polarizable electrode and the electrolytic solution.

[0017] This result is shown in Table 1.

[0018]

[Table 1]

	pH	容量(F/g)	耐久性(%)	効率(%)	電圧(V)
本発明	3	25.0	85.5	97.8	2.5
	9	23.0	87.5	99.1	2.7
	11	22.5	88.0	99.4	2.5
従来例	電極 pH 3 電解液 pH 8	23.0	83.0	98.6	2.5

In Table 1, after it repeated charge and discharge 5 times from 0V to 2.0V by 0.6 V/min, effectiveness measured the 6th charge afterdischarge current, and it was comparatively used as the charge charge and the discharge charge, and it measured it. Moreover, capacity was computed from the electrical potential difference between terminals, and the amount of charge charges, after charging [ 6th ] in the case of measurement of the effectiveness mentioned above. Moreover, endurance was measured as a ratio of the capacity after carrying out the charge and discharge test of 100W 100,000 times, and initial capacity. Moreover, in the electric double layer capacitor, an electrical potential difference means the electrical potential difference on which an irreversible current began to flow, and shows the limiting element voltage of each electric double layer capacitor. In addition, the conventional example is also shown for the comparison. as for this conventional example, pH of an electrode and the electrolytic solution becomes equal -- as -- it was not constituted but was pH=3 of a polarizable electrode, and pH=8 of the electrolytic solution.

[0019] As shown in Table 1, in any case, endurance of this invention is improving from the conventional example. Furthermore, when pH is 3, capacity becomes the largest, when pH is 9, an electrical potential difference can be made the highest, and in the case of pH11, effectiveness is improving most further. It is thought that these reasons are as having mentioned above, respectively.

[0020]

[Effect of the Invention] Since pH of a polarizable electrode and the electrolytic solution was made equal according to this invention as explained above, the reaction of the surface functional group of activated carbon and the electrolytic solution is controlled, and endurance can be raised.

[0021] Moreover, if pH is made into the nine neighborhoods in this case, since immersion potential will become the lowest, high-voltage-ization can be attained with endurance.

[0022] Moreover, since an acid functional group increases in an activated carbon front face when pH is made less than into nine, high capacity-ization can be attained with endurance.

[0023] Furthermore, since a basic functional group increases in an activated carbon front face when pH is made larger than 9, efficient-ization can be attained with endurance.

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## CLAIMS

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### [Claim(s)]

[Claim 1] The electric double layer capacitor which is an electric double layer capacitor which has the electrolytic solution with which it sank into the separator which intervened between the polarizable electrodes of positive/negative, and these polarizable electrodes, and said polarizable electrode and said separator, and is characterized by making equal pH of said polarizable electrode and said electrolytic solution.

[Claim 2] The electric double layer capacitor characterized by said pH being 9 in an electric double layer capacitor according to claim 1.

[Claim 3] The electric double layer capacitor characterized by said pH being less than nine in an electric double layer capacitor according to claim 1.

[Claim 4] The electric double layer capacitor characterized by said pH being larger than 9 in an electric double layer capacitor according to claim 1.

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